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BRIEF NOTES ON THE ECOLOGY OF THE RESURRECTION PLANT (*MYROTHAMNUS FLABELLIFOLIA*) WITH MENTION OF ITS WATER-ABSORBING ABILITIES.

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ABSTRACT.

Myrothamnus flabellifolia is a woody geophyte occurring on exposed granite outcrops in Central Africa, where it is subjected to violent extremes of available moisture.

Its establishment is probably the initial step in the colonization of such habitats by other plants. This may, in part, be due to the fact that the plant has become adapted to conditions of severe wilting by folding up its leaves and subsiding into a state of suspended animation.

When moisture again becomes available it is usually in plentiful supply and is absorbed by the plant from the soil, little, if any, use being made of moisture absorbed by the aerial parts of the plant.

INTRODUCTION.

The Resurrection Plant is a woody geophyte occurring in rocky habitats in Central Africa (Phillips 1951). It has the ability to revive rapidly from a state of considerable desiccation which is accompanied by an overall change in the colour of the plants. Coupled with its characteristic aromatic odour, this power of revival has given the plant considerable healing powers in the eyes of the tribal Africans.

All the material used in this study was obtained in the Matopo Hills. Southern Rhodesia. where it grows on expansive outcrops of solid granite. The plants grow singly or in clusters, some of which are over 20 yards across.

HABITAT.

The plant grows on flatter shelves on the massive granite outcrops on which it is fairly common. Six measurements of the slopes across clusters of plants never exceeded 1 in 4. for a very small colony. and were usually much less. Numerous observations showed that the largest colonies were on very slight slopes of about 1 in 10 to 1 in 20. The plants are always on well-drained sites and three transplants placed in hollows. known to hold water for considerable periods. died within three weeks. while others grown on flat areas survived. Thus it would appear that the plants are susceptible to water-logged soils.

Myrothamnus withstands considerable local extremes, growing as it does on exposed rock faces and has never been observed to occur in sheltered localities. whether the shelter be provided by rock or plant. In this study the rapid changes of available moisture are of particular interest. After rain. water is always plentiful due to the run-off from the granite but this soon evaporates.

From a general investigation of the slopes where the colonies grow it seems that *Myrothamnus* is at least partly responsible for providing suitable habitats for other plants otherwise only found in sheltered or moist localities. The age of the *Myrothamnus* colonies was judged on the bushiness of the aerial shoots and it seems that the younger less bushy clusters are usually lower on any particular slope. This conjecture is supported by the condition of the soil beneath the various aged colonies. The soil is derived from the erosion of granite. and under a young colony contained a high proportion of fresh granite chips. relatively little fine-grained material and very little organic material. The proportion of fresh acutely-angled particles falls away to almost zero under the oldest colonies. while the proportions of the other two components rise. Typical of the soil from an old colony is fine dust with very few large particles and containing a great deal of organic material. both living and dead.

The organic material seems to come from three main sources:

(*a*) There are the living roots of the *Myrothamnus* which seldom reach a depth of more than eight inches, (*b*) with increased age of the colonies there are more and more associated plants, and

(*c*) beneath all colonies there is a considerable amount of small mammal droppings.

The explanation for the presence of the last is not obvious as, besides a few beetles which feed off the *Myrothamnus* and bees which visit the male plants for pollen, there is no evidence of any other animals utilizing the Resurrection Plant.

It is tentatively suggested that *Myrothamnus* is an early colonizer of the coarse soil deposited on the granite shelves by the slackening of eroding currents. When such sites are suitably drained *Myrothamnus* becomes established on them, and then aids the formation of a richer soil by supplying and trapping organic material that may include the animal droppings washed down from a higher level. The plant itself provides a certain amount of shelter, and in the habitat so formed more and more associated plants become established. These include mosses, the two ferns *Pelea viridis* and *P. calomelonos*, one or two angiosperms and *Selaginella dregii*, all of which favour to some extent sheltered or moist localities. Higher up the slope, above the oldest colonies, there is often a well established patch of grass which, it is suspected, gradually replaces the Resurrection Plant, for in at least one such locality there is a straggling crescent of very old *Myrothamnus* bushes on the down-slope side of a large grassy patch. Thus it appears that the establishment of *Myrothamnus* is the initial step in the succession by which grass and even shrubs and bushes colonize the rocky slopes.

MORPHOLOGY AND CONDUCT.

The size at which plants become sexually mature varies, and plants nine inches high will bear flowers. The general impression gained was that smaller plants produced flowers when isolated, rather than those in large clusters. However, the plants are composed of a creeping trunk, often obscured by litter, from which arise numerous aerial shoots, and it is therefore not surprising that the flowers of robust plants are on longer branches than on the smaller lone plants. They are very woody and sections of root and stem show that both have a high percentage of xylem.

It seems that *Myrothamnus* can stand severe desiccation and it is in this "dry" condition that it survives for most of the year. When "dry" the living apical shoots (from the tip to the third node) have been found to contain as little as 11 per cent water by weight and the plant is then a dull grey-brown colour. However, when revived in water similar apical shoots, now green, have been found to contain between 70 per cent and 75 per cent water.

The leaves are palmately veined and decussately arranged in clusters, mostly at the apices of short branchlets, the lower parts of which are covered by leaf scars. When the plants are "dry" the leaves are folded along the veins and also upwards so that portions of each leaf and the younger leaves, and bud, are protected. Sectioning shows that the leaf cells are small and most of the stomata are on the upper surface. When dry the dull colour is due to most of the photosynthetic regions being masked by this folding and probably to some other internal mechanism.

When moisture becomes available to the plant after rain, or when cut branches are placed in water, the leaves unfold and the plant becomes much greener. In the field during summer (November to March), when rain followed a dry spell of about two weeks, all the leaves opened but after four or five days the two lower leaves on each shoot yellowed and fell off. This could be repeated in the laboratory with cut branches but when it was repeated in winter (August) the lower leaves fell away without greening and many others which greened only partially, on surfaces which had been protected by lower leaves, also fell off if the branch were agitated, sometimes leaving only the bud.

This possibly indicates that most leaves are lost in spring after the first rains but that they are also shed throughout the interrupted growing season. It would mean that the retention of the older leaves for the winter facilitates the protection of the bud and younger leaves during the longest period of quiescence.

WATER RELATIONS.

Most of the evidence in this section was obtained from experiments on cut shoots carried out in the laboratory. For this purpose plants were cut, and if green were dried, in preparation for transport from Rhodesia to Cape Town. All the same it is reasonable to suppose that conclusions formed from the data collected in this way applies to plants in their native environment.

As has already been stated, *Myrothamnus* revives from the "dry" state remarkably quickly although this cannot be compared for speed of hydration exhibited by some of the cryptogams. Although a shoot 20 cm. long looks quite green after six hours in tap water, it takes about 36 hours for the apical shoots to attain their maximum turgidity of 70 per cent to 75 per cent water by weight. While reviving, the basal shoots open out first and from here the greening spreads progressively upwards towards the most apical shoots. The progressive greening applies equally well to both plants in the field and cut shoots placed in a solution.

There are four possible routes by which a fluid can reach the leaves during the hydration of a cut shoot:

(*a*) Water or water vapour could be absorbed by the aerial parts of the plant;
(*b*) fluids which will travel rapidly up the rough bark by capillary action could enter the transpiratory stream;
(*c*) solutions could enter the wood at the cut end of the shoot; or
(*d*) an important contribution could come from more than one of the above.

(*a*) Selected uniform samples of "dry" twigs did not revive, even in an atmosphere of 100 per cent water vapour pressure, when kept in desiccators with known humidities maintained by the aid of fixed concentrations of sulphuric acid. The results of this experiment are shown in Table I.

TABLE I.

The difference in the weight of samples of shoots, kept in known humidities, after 48 hours.

% H_2O vapour pressure.	Original wt. when dry.	Final wt.	% change in wt.
	gm.	gm.	
100·0	2·49	2·72	5·2
88·5	2·45	2·51	2·4
56·8	2·67	2·68	0·3
17·2	2·53	2·53	0·0

The samples in the two highest humidities did gain a little weight, but this is negligible when it is borne in mind that apical shoots will gain something like 70 per cent of their dry weight in only 36 hours while the increase in 100 per cent water-vapour pressure is something of the order of only 10 per cent. After a week the sprigs in the two highest humidities were covered by a fungal growth, showing that the bark had become sufficiently moist to support it. It is reasonable to conclude that any increase in weight was due to this. An interesting point which arises from this experiment is that although an intensive search was made in the field for fungal infection on the plants, none was found. It may be that the very dry state of the plant for most of the year acts as a deterrent to such an infection.

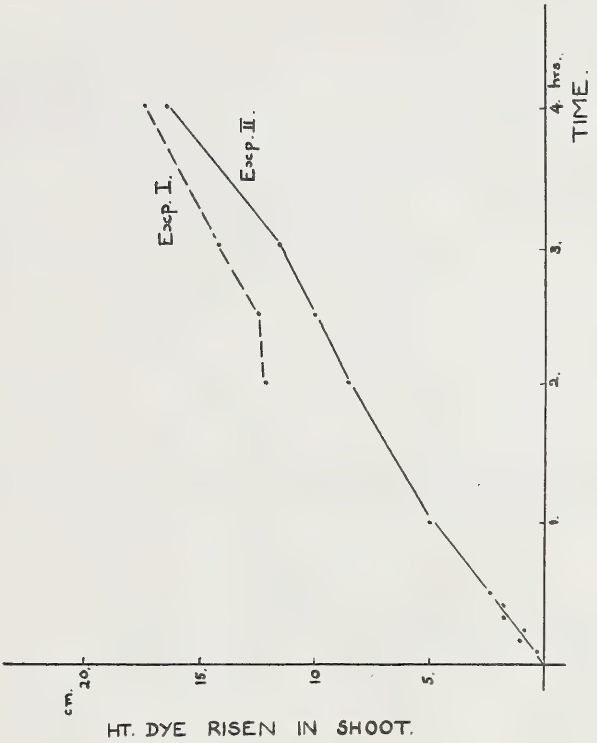
When a number of similar twigs were placed in water, some erect and some inverted so that the water covered a number of the leaves, it was found that the former greened most rapidly. Further, on the inverted twigs only the leaves in the water and those immediately above its level responded. Of these, opening was most rapid by any that were damaged. This was confirmed by cutting some of the leaves on a "dry" twig before inverting it in water, whereupon the mutilated leaves responded most rapidly. Any water entering this way through wounds would then fall under (*c*) above.

It, therefore, seems that (*a*) is, at most, a rather unimportant route via which fluid can reach the leaves during hydration. Similarly in (*b*) it was found that very little liquid which was absorbed by the bark entered the wood. The cut ends of twigs were sealed with wax before being placed in a 1 per cent aqueous solution of fluorescein. The height to which the dye climbed the bark varied to some extent depending on its nature, particularly its roughness which seems to be correlated with age. On most of the material which had previously been selected for uniformity it reached 20 to 22 cm. The minimum recorded on a fairly young shoot was 8 cm. and the maximum of 32 cm. occurred on an old branch with very cracked bark. However, when longitudinal sections were cut and viewed under ultra violet light after 24 hours in the dye, none had entered the wood and the plants had not greened at all. By this time control material which had not been treated with wax was quite green.

The above observations leave only the internal routes (*c*) for most liquid to reach the leaves. To confirm this, branches were placed in fluorescein dye and then by cutting longitudinal sections under ultra violet light, after different time intervals, it was possible to estimate the rate at which it ascended the system. By this method it was also found that it took place mainly in the xylem. For each series of readings uniform material was selected and the results of two such experiments are shown on Graph I, which indicates that the rate of ascent is directly proportioned to time.

This is only so in uniform material and is governed, to some extent, by the distribution of the leaves. Three uniform shoots were shorn of leaves for varying heights and the wounds were plugged with soft wax before placing them in the dye solution. In all cases it was found that in 20 minutes the dye only reached the lower leaves in any quantity. As far as this there was a strong stream but above the first two-leaf-bearing branchlets the stream was very weak and soon tailed off.

It thus seems fairly certain that most of the solution entering the leaves does so via the xylem and that this is in response to the leaves themselves.



Graph I.

The results of two experiments where the rate of the ascent of a dye in the stem was compared with time using samples of uniform material.

CONCLUSION AND DISCUSSION.

The habitat in which *Myrothamnus* grows is one of extremes, especially regarding the availability of water. The soil is shallow, seldom more than a foot deep, and even then the plants' roots are largely confined to the top eight inches or so. On the exposed rocky outcrops, on which the plants grow, this soil is very quickly dried especially as colonies have always been found to be well drained and so only the moisture which the sandy granite soil can hold is retained for long after a rain. However, run-off from the granite during showers of rain ensures that the plants are provided with ample water at such times. In brief, when there is water there is plenty of it but this is only for short periods of the year.

It is during these periods and for a short time afterwards that the plants are green and then presumably perform their major life functions. When water is short the plants are able to survive in a quiescent state. Then the leaves fold up and protect the tender buds. It seems that this is the method used by the plant to survive periods of severe wilting. When rain again falls and is amply available to the roots, it is drawn up by the leaves through the xylem and little, if any, enters by other means. It hardly seems probable that the amount which could enter the aerial branches is of any significance when compared with the abundant supply available to the roots. After all, in such circumstances does the plant need to use any other mechanisms?

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